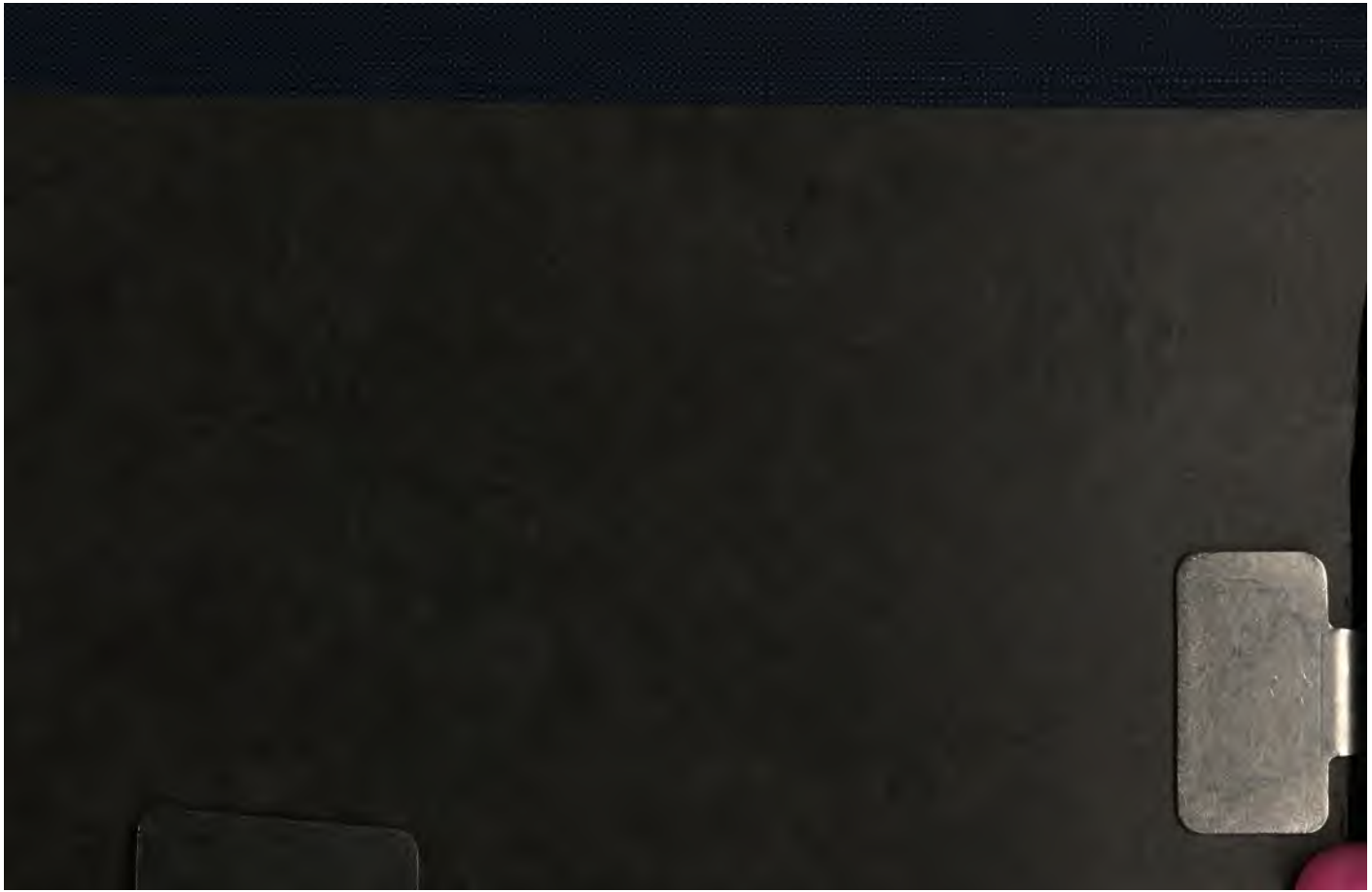

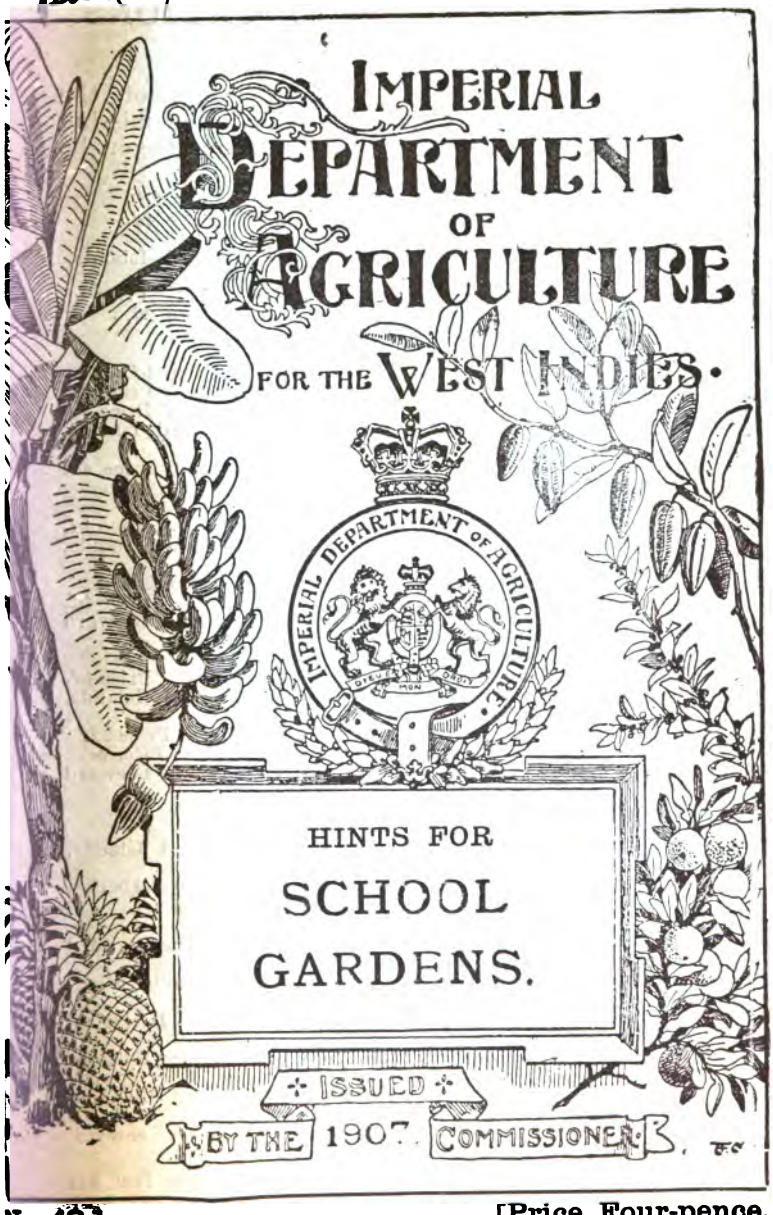

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No. 48.

IMPERIAL
DEPARTMENT OF AGRICULTURE
FOR THE WEST INDIES.

HINTS FOR SCHOOL GARDENS.

BY A. H. KIRBY, B.A.,
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Antigua.

ISSUED BY THE COMMISSIONER OF AGRICULTURE.

1907.

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PREFACE.

A small pamphlet entitled *Hints for School Gardens* was issued in November 1901. This was intended for the use of teachers in elementary schools, who had attended the courses of instruction delivered, from time to time, by the Officers of this Department.

Practically every primary school in the West Indies now includes elementary agriculture in its curriculum. With the view of meeting the increasing demand made by teachers for directions for the cultivation of plants in boxes and pots and for laying out school gardens, the original pamphlet has now been re-written and much additional information added. It is hoped by such means, instruction for the raising and caring of plants may be taught, along uniform lines, and simple rules observed for carrying out such experiments as are within reach of the teachers and the taught.

In order that the methods adopted in the practical work may be thoroughly understood, it is of great importance that the details should, as far as possible, be carried out by the pupils themselves.

Practical instruction in the elements of agriculture has an important educational value, as it affords

an excellent opportunity for training even the youngest pupils in the habits of close and accurate observation. It also teaches them to examine carefully what they see, and to follow the connexion between cause and effect. It further shows how the principles adopted in the field have been evolved from correct inferences based upon careful and accurate observation in the garden.

Schools which have not the necessary space for a garden can do much with box and pot cultivation, for this is available everywhere. The first section of the present pamphlet deals with what is possible to be done even with a few boxes in interesting children in plant life. As stated, the pupils must be put through a good course of box and pot culture and be led to master thoroughly the principles underlying it before they are allowed to proceed to the wider cultivation of plants in garden plots.

The work in garden plots has been arranged in eight lessons, but any one lesson may, and in most cases certainly will, occupy the time allotted to several meetings of the class. By following this course of work, every pupil should obtain a general knowledge of different methods of multiplying and successfully growing most garden plants.

After the courses of general work of the garden has been completed by the class as a whole, specialized work may be commenced, the plots being allotted amongst the most promising pupils, as they show aptitude for the work. To render this easy and interesting, special instructions as to the cultiva-

tion of twenty-five different crops, familiar in the tropics, are given. The directions are brief and precise, designed to exercise the reasoning faculties of the pupils. While at the end of the pamphlet, exercises in such practical work as budding, grafting, and pruning are described in detail.

I would add that I am greatly indebted to Mr. A. H. Kirby, B.A., for the careful manner in which he has prepared this pamphlet; and I trust it will prove of value to teachers in elementary schools, who are recommended to use it in conjunction with *Nature Teaching* prepared by Dr. Francis Watts, C.M.G., a new Edition of which is proposed to be issued by this Department.

Commissioner of Agriculture
for the West Indies.

June 17, 1907.

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BUDDING, GRAFTING, AND PRUNING.

SCHOOL GARDENS.

INTRODUCTORY.

Instruction in the school garden is not given merely for the purpose of showing how to grow vegetables, any more than the ordinary teaching in schools has for its object the winning of prizes. It derives its value from its usefulness in training the intellectual faculties, especially those of observation and correct inference, and its power to do this is the best indication of its true worth. Knowledge useful to the agriculturist is gained incidentally, and the material profit arising from the produce of the soil may be an incentive to painstaking efforts on the part of the learner.

Pupils should be put through a good course of box and pot culture and should thoroughly master the principles underlying it before they are allowed to proceed to the cultivation of plants in plots. The latter is a repetition of the elementary work on a larger scale, but does not serve so well as a means of imparting knowledge connected with plant life, as its processes are not under such immediate control; it is intended to show how the methods adopted in practice naturally have their foundation in ideas derived from careful and accurate observation, and

to provide exercises in actual agricultural procedure. At all stages, the teacher should seize every opportunity which affords itself of demonstrating the processes of nature, so that his course of instruction will include facts concerning animal life, especially that of insects.

GENERAL INSTRUCTIONS.

SIZE OF PLOTS.

The most convenient size has been found to be 20 feet by 5 feet. In marking these out, lines of fairly thick cord, about 22 feet long, tied to stakes, should be used, and employed whenever the necessity arises for remaking the plot. Straight wooden rods, 5 feet long, marked at each foot by a shallow cross cut, and others, 1 foot in length divided in the same way into inches, are indispensable in arranging for the width of the plot and the distances between rows and that of the holes in them. The width of the paths between the plots may be from $1\frac{1}{2}$ to 2 feet.

DISCIPLINE.

Pupils should never be allowed to work in the garden without a responsible person in charge. They should not be allowed to visit the tool shed during the time that the class is being held unless special permission is given. At the end of it they should form up in line, with the tools they have been using, and then be called out one by one, by name or number, from the line. As each one leaves it, he cleans the tool by dipping it into water cover-

ed with a little kerosene and wiping it with a coarse cloth provided for the purpose. In wet weather a preliminary cleaning with a small piece of wood will be necessary. A note-book must be kept by every pupil, showing the date when each piece of work was done, the method of procedure and the results obtained, and giving the reasons for the process. The notes should be based on the observations made and the work done in the garden, etc., and on the verbal instruction given by the teacher; they should not be dictated by him, for then they will be of far less value as a means of impressing on the mind the knowledge gained, and as an indication of the progress of the pupil. The weekly correction of such notes by the teacher is a matter of necessity.

DISTANCES FOR PLANTING AND PERIOD OF GROWTH.

Green plants obtain most of their food from the air, by means of the leaves. (*Nature Teaching*, pp. 78-83.) Care should therefore be taken that the leaf development is not hindered by overcrowding, needless removal or injury, or by the attacks of insects or fungi. Again, the more leaves plants possess, the greater is the root development, so that they should not be allowed to grow so closely together that the latter is hindered. In a poor soil there is naturally less mineral plant food under a given area than in a rich one; therefore, roots tend to spread in it rather than to branch extensively; thus its state in this respect, as well as the ultimate size of the plant and

the direction in which its roots grow, should be considered in determining the distance at which to plant. In the instructions which are given later, the distances recommended are the best for ordinary conditions and allow for the proper growth of the plant above and below ground, but they may require modification at the teacher's discretion, according to the condition of the soil in which cultivation is being carried on. The time which the produce of the plant takes to come to maturity is also stated but can only be approximate, as it varies with the climate and season; it is therefore only given as a rough guide toward determining when a plant should be reaped. Some plants, such as yams and ginger, do not form a crop suitable to be raised by a single pupil, as their produce requires a long time to come to maturity; they should rather be grown in a plot for demonstration purposes.

BOX AND POT CULTIVATION.

Schools which cannot, for any reason, attempt a garden in the proper sense of the word can do a great deal with cultivations in pots and boxes.

It might be advisable in all schools to commence with box and pot cultivation. Many of the more important points in agricultural practice, such as drainage, the proper breaking up of the soil, and the results of manuring, can be well demonstrated in this way. The expense will be very little at the beginning, very few tools being required. The labour is very light and thus not likely to arouse the prejudices of some parents, as hoeing and forking

sometimes do. These prejudices against the work will, no doubt, disappear in time; but whilst the subject is comparatively novel it is wise to avoid arousing them.

The pupils should be taught to keep careful notes of everything they do. They should be able to turn to their note-books and say what crops have been grown in any particular bed; when any plants were sown, when they first flowered and fruited, and how long they remained in bearing. In the case of manurial and other experiments, they should first write out what the experiment is intended to show, how it is to be carried out, and, later, give the results obtained.

Box and pot cultivations may then form the starting point for all school gardens. Those schools which cannot go farther must confine their attention to these, gradually extending their scope as is found practicable.

The schools which have room for a garden can commence by raising plants in pots and boxes. Very shortly the desirability of planting out some of them in the open will arise, and one or more garden beds should be prepared, the requisite tools being bought as required.

TOOLS, ETC., REQUIRED.

A supply of boxes and pots is the first requisite. These can be obtained without much expense, as many waste household articles can be utilized. Any stout wooden boxes and kerosene tins are extremely

useful, and many small plants may be grown well in small tins, such as old butter tins.

A few pots, bamboo or earthenware, should be obtained, and also a shovel and trowel, soil, some cocoa-nut fibre refuse, and a little sand.

A sieve is very useful, but, as a rule, expensive. Very good substitutes may be made for a small sum with fine-mesh wire-netting nailed on to a small shallow box with top and bottom knocked out, or by replacing the wire-netting by a sheet of tin pierced with holes about ¼ inch to ½ inch in diameter.

Two sizes of boxes are wanted : shallow ones for raising seedlings in, and deeper ones for transplanting them into later.

Flat slips of wood about 6 inches long by 1 inch broad, smooth on one side and pointed at one end, should be obtained for use as plant labels.

SEED BOXES.

The seed boxes should be shallow, from 4 to 6 inches in depth, with sides securely fastened so that they will bear the weight of the moist soil. Ordinary wine and whisky cases answer very well, and useful seed boxes can be made from the bottoms of kerosene tins. Bore a number of holes, about ½ inch in diameter, in the bottom of each to secure good drainage. Stand the boxes on a layer of small stones or ashes.

I. PREPARATION OF BOXES AND POTS.

1. See that the boxes and pots are quite clean.
2. Soak pots in water before filling them.

3. Bore several holes, in neat rows, in the bottom of the boxes and tins. The holes should have a diameter of ¼ inch to ½ inch.

4. Sift a quantity of as good soil as is obtainable, and place the sifted soil and stones in separate heaps.

5. Put a layer of the stones so obtained at the bottom of the box.

6. Over this, place a layer of decayed, shredded plantain (or banana) leaves, cocoa-nut fibre, or grass.

7. Cover this with smaller stones or gravel and then fill in with the sifted soil to within a short distance of the top.

8. Level the surface of the soil with a piece of board with a straight edge.

Explanation.—(*a*) Plants grown in dirty boxes and pots are likely to be attacked by fungi and insects, as the spores and eggs are harboured by dirt. Such attacks are especially serious in the case of very young plants, for they require all their energy for quick growth, so that there is none left to enable them to resist enemies. It is also easily seen that they have no thick protective covering, such as that possessed by older plants, to aid them in this. (*b*) Pots are porous and should be well soaked in water before soil is put into them or they will rob it of moisture. (*c*) The stones, etc., put at the bottom of the boxes form the 'drainage,' and prevent the air-spaces in the soil from becoming filled with water. This is important, as roots must have air.

II. WAYS IN WHICH SEEDS GERMINATE.

1. Moisten the soil well with water and allow it to drain.

2. If the seeds are very small, tear off a corner of the envelope or packet containing them and, gently tapping it, sow them thinly over the surface; then cover with a thin layer of soil.

3. Sow larger seeds in small drills or holes made with the finger, if boxes are being used. Large seeds sown in pots should be pressed into the soil about half their own depth and then be covered with fine earth.

4. In all cases, press down the soil with the palm of the hand or with a flat piece of board fitted with a handle.

5. Water very carefully every day, using a watering-pot with a fine rose.

6. Small seeds, such as those of the onion and lettuce, are likely to be carried off by ants. If there is danger of this, nail a strip of wood about a foot long and 1 inch wide to each corner of the box, so as to form four legs, and stand it in tins containing water. Another method is to water carefully, immediately after sowing, with a mixture consisting of a teaspoonful of kerosene to a pint of water, keeping it well stirred.

7. Provide shade for the seedlings. The way in which this is done will be determined by the means at hand.

Explanation.—(*a*) If seeds are sown too deeply, the young plants only just reach the surface of the

ground, or not at all. (*b*) The soil is pressed down over the seeds in all cases, so that their coats may come into close contact with it and easily take up the water necessary for germination from it. In the case of plants whose cotyledons come above the ground, the soil must be compact, or there will be nothing to hold the seed-coat while they are being pulled out of it. (*c*) Note especially the arch below the cotyledons in the case of plants like the bean, castor oil, and cotton ; the arch above the cotyledons in that of the pigeon pea : the curved green portion (*hypocotyl*) between the radicle and seed-leaves, with the swelling on it, of the pumpkin, squash, strainer-vine, etc. : and the root-sheath and seed-leaf outside of the seed in that of very young palm seedlings; in the last case the plumule bursts through the stalk of the cotyledon. (See *Nature Teaching*, pp. 5-13.)

III. THE TIME TAKEN BY SEEDS TO GERMINATE.

1. The observations are made on the seeds sown in II.

2. Only one kind of seed should be sown in each box or pot.

3. Each box or pot must contain a label on which are written : (*a*) the name of the seed sown, (*b*) the date, and (*c*) the name or names of the pupil or pupils by whom the experiment was begun.

4. A careful examination should be made every day until the first sign of germination is seen.

5. Note that, generally speaking, the seeds which have the thickest coats take the longest time to germinate.

IV. NECESSITY OF SHADE FOR VERY YOUNG PLANTS.

1. Seeds are germinated in the way described above.

2. As soon as the first ordinary leaves of the plants begin to form, some of the boxes containing them are put in the sun.

3. The plants in the boxes placed in the sun first droop and then wither, becoming quite dry.

Explanation.—(*a*) Plants in the sun give off water more quickly than those in the shade, and their roots, when they are very young, have not grown sufficiently to take up water quickly enough to keep them alive. (*b*) Very young plants give off water from every part of them as their outer covering is still very thin.

V. THE SUPPLY OF WATER TO PLANTS.

1. Prepare boxes or pots in the way described in I.

2. Sow seeds in them and tend carefully according to the instructions given in II. Label this series, Experiment A.

3. Treat other boxes or pots in the same way but, after the seedlings are about 3 inches high, withhold water. Label this series, Experiment B.

4. Into a third series of boxes or pots, place fine soil alone without any drainage, having first stopped up the holes. In them sow the same kind of seeds as were planted in A and B. Water sparingly until the seedlings are about 3 inches high and, after this, keep the soil well soaked, pressing it down. Label this series, Experiment C.

5. The seedlings are observed to grow well in Experiment A, while in Experiments B and C they ultimately wilt and die; in the former soon after the water is withheld, and in the latter soon after it is supplied in excess.

Explanation.--(*a*) In Experiment B the plants die after they are deprived of water, because water is required by all living things, especially when they are actively growing. (*b*) The wilting or drooping of the plants takes place because the cells are no longer tightly filled with water, and so the plant loses its stiffness. (*c*) A young plant dies sooner than an older one during drought because water quickly escapes through its thin outer covering. [See IV, (*b*).] (*d*) In Experiment C, the importance of free drainage of the soil in the case of most plants is shown. Generally, the water held between the most nearly touching of the particles of soil is quite sufficient for a plant's needs, while, at the same time, the roots must be supplied with air. As the larger spaces in the soil are filled with water, owing to the fact that the excess of it cannot drain away, the air is driven out.

VI. RAISING PLANTS FROM CUTTINGS.

1. Fill boxes in the ordinary way (see I) with very sandy soil, or with sand mixed with a little soil, and water well.

2. Cut young, woody slips of the plant to be propagated (hibiscus, rose, croton, coleus, aralia, etc.) about 6 inches long, making the lower cut very oblique and just below a node. A sharp knife must be used. Remove nearly all the leaves.

3. Push the cutting, to a depth of about 3 inches into the soil and press well round it with the fingers.

4. Shade and water as in the case of seedlings.

5. Pinch off any flower buds that appear on the young plant.

Explanation.—(*a*) In sandy soil the spaces between the particles are large, so that the young roots are plentifully supplied with air and water, both of which are necessary. (*b*) Roots easily push their way through sandy soil. (*c*) By making the cut oblique, a larger amount of the cambium layer, from which the roots grow, is exposed than if it were made straight across the slip. (*d*) The cut is made near a node as it is there that the activity of growth is greatest; leaves and branches always arise near the nodes. (*e*) Jagged wounds do not heal well and are therefore likely to cause decay, so a sharp knife should be used. (*f*) The presence of many leaves on the cutting causes a great loss of water through their pores (stomata) which cannot be made up for from the soil, as there are no roots by which it can

be taken in. (*g*) Unless the soil is pressed round the slip, water easily escapes from the spaces left in it. (*h*) All flowers which form while the plant is still young are removed because the growth of fruit and seeds takes away the plant food which is required for the formation of necessary roots, branches, and leaves.

VII. RAISING PLANTS FROM LEAVES.

1. Cut off leaves of begonia, 'thick leaf,' or peperomia close to the plant.

2. Cut across the larger veins with a penknife and lay them in boxes of sandy soil with the leaf-stalk in the soil.

3. Sprinkle a little wet soil on the cut parts of the leaf and, over this, place small stones to hold it down.

4. Separate, and carefully transplant, the young plants as they arise.

Explanation.—(*a*) If the leaf-stalk is buried in the soil the leaf is less likely to dry up and decay quickly than if the end of it is exposed. (*b*) The cutting of the veins promotes the growth of roots in the same way as the removal of the part of the stem near a node does in the case of cuttings.

VIII. TRANSPLANTING SEEDLINGS.

1. Water the soil in the seed-boxes well.

2. Make holes in the soil in the boxes to which the seedlings are to be transplanted.

3. Carefully lift the seedlings with a trowel or hand-fork and place them in the holes prepared for

them, at a depth equal to about half their total height.

4. Press the soil round them carefully with the fingers.

5. Water and keep shaded.

6. Place the boxes containing the transplanted seedlings in the sun for an hour or two each day in order that they may 'harden off.'

Explanation.—(*a*) Watering the soil in the seed-boxes renders the lifting of the seedlings easier, and the soil clings to their roots more readily. (*b*) Seedlings require to be 'hardened off' at first because their comparatively small growth of roots is not yet sufficient to keep up the water supply required by leaves in full sunlight. They should be placed long enough in the sun to gain the advantage of the increased rate of formation of food, which results from the action of direct sunlight, as this causes the speedier production of roots, but not sufficiently long to cause a serious loss of water. (*Nature Teaching*, pp. 73-81.)

IX. TRANSPLANTING TO LARGER POTS.

1. To remove a plant from a pot, turn it upside down, place one hand on the surface of the soil to support it and, keeping it in this position, tap the rim of the pot on the edge of the potting bench, when the plant will be removed, with the soil about the roots undisturbed.

2. Place the plant in the middle of the new pot into which 'drainage' has been previously placed,

and press sifted earth round the soil left on the roots (See I).

3. Remove some of the leaves and water the plant.

4. Provide shade, prune away the youngest parts of the branches, and nip off all flower buds as they appear.

Explanation.—(*a*) The plant is removed carefully from the pot so that the particles of soil may not fall away from the roots and in order that the latter may not be injured and, as a result, unable to supply the water required by the plant. (*b*) As the formation of flowers, fruits, and seeds entails the supply of a large amount of plant food, all flowers are pinched off as they appear, in order that this food may be used for the growth of the stem, leaves, and roots until the plant is well established.

X. THE CARE OF ORNAMENTAL POT PLANTS.

1. The soil should be placed above a good drainage layer, as is described above. Stand the pots in which plants are growing in shallow earthenware dishes or saucers.

2. Great care should be taken in watering, so that the soil may never become swamped. Water ferns with rain-water.

3. Place a mulch of cocoa-nut refuse or chopped grass on the surface of the soil.

4. Pinch off some of the leaf-buds, with the object of making the plant branch evenly and not too thickly.

5. If the plant tends to grow long and straggling, remove the uppermost buds.

6. Prevent flowers from being formed, until the plant has almost reached its full growth, by pinching off the buds.

7. Encourage quick flowering, when the plant has developed sufficiently, by keeping the roots confined in a small pot.

8. In cutting the flowers, remove as little of the young wood as possible.

Explanation.—(*a*) The supply of too much water causes the spaces between the particles of soil to become filled up, and the roots cannot obtain the air which is necessary to their growth. (*b*) When water is thrown on to soil, it tends to make the surface hard and compact, so that it does not easily absorb it any longer; mulching plants in pots prevents this, by breaking the fall of the water. (*c*) The removal of the uppermost leaf-buds causes growing points lower down to become active, with the result that low branches are formed. (*d*) If a plant is allowed to form flowers at too early a stage in its life, food is taken away, which is required for growth. (*e*) Plants form flowers only when they contain a reserve store of plant food. In order to produce such a reserve, special attention should be given to the following points: (1) manuring the soil; (2) giving plenty of light and air so that leaves may form readily; (3) protecting the leaves so formed from injury by insects and fungi, and (4) causing growth to be partly checked by withholding water,

removing the shoots that are growing most actively, or by allowing the roots to be pot-bound.

XI. THE TREATMENT OF PLANTS WITH THE OBJECT OF THE PRODUCTION OF FLOWERS.

1. Keep the plant in a small pot, so that it is 'pot-bound.'

2. When the plant arrives at the blooming period water sparingly, only giving sufficient to keep it alive.

3. Cut all flowers as soon as they are open; on no account allow any to form fruit.

4. Generally speaking, if the plant is being kept for another blooming period, avoid cutting away the young, woody branches as far as possible.

Explanation.—(*a*) If a plant is grown in a small pot it arrives at a stage when the soil is so fully occupied by the roots that a difficulty arises with regard to the further provision of food for them; it is then said to be 'pot-bound.' Generally, the result of such a condition is that the plant ceases to produce much vegetative growth (leaves, branches, and roots) and aims at the reproduction of its kind by giving rise to flowers so that seeds may eventually be formed. (*b*) The lessening of the supply of water contributes to the same result in the same way. (*c*) No fruits should be allowed to form, as this will take away plant food which would otherwise go to the making of flowers. (*d*) Great variation occurs, as regards different kinds of plants, in the age of the branches which usually produce

the flowers, but in the case of many pot plants they are those which have most recently become woody.

XII. POLLINATION IS GENERALLY NECESSARY FOR THE FORMATION OF FRUIT.

1. Choose plants which readily yield fruit under ordinary conditions and which are forming flower-buds.

2. Treat some of the flower-buds in the following manner: turn back (or carefully remove with scissors) the calyx and corolla before the bud opens, and cut off the anthers.

3. Carefully place a paper bag over each of the flowers so treated and tie the mouth with thread.

4. All the flowers with regard to which this procedure has been carefully observed will die without forming fruits.

Explanation.—(*a*) The anthers of most unopened flower-buds have not yet let the pollen free, and the latter has not reached the stage at which it can be of use in causing fruit to form. (*b*) The placing of a bag over the flower prevents pollen being carried to it from another one. (*c*) It should be noted that there are exceptional cases in which fruits arise where no pollination has taken place, but that these fruits are always seedless. For instance, the banana is almost always without seed; seedless varieties of the apple and pear are known, and the orange, grape, and cucumber sometimes form fruits without pollination of the flower. (*Nature Teaching*, pp. 136-47.)

XIII. MANURING.

Plant food which is got from the soil is dissolved in the water taken in by the root-hairs. The food supply from this source is most likely to be deficient in nitrates, phosphates, and potash. The continual loss of these through their removal in the crops reaped renders them important to the cultivator; nitrogen is especially so, as the nitrates, being very soluble, are also lost in the water which drains from the land. Convenient sources of nitrogen are farmyard or stable manure and compost, which, when fresh, do not contain it in a soluble form, but in which nitrates are slowly formed when they rot. During the process of rotting, injurious fungi and the seeds of weeds, which the manure is likely to contain, are, for the greater part, destroyed. For these reasons such manure should never be used until it has been kept for some time, preferably covered with a layer of earth which helps to prevent the escape of ammonia and therefore loss of nitrogen. Plants which are raised for the purpose of providing fruit or seed will often bear the maximum amount in soil which contains insufficient plant food, but this will be at the expense of the *vegetative* growth, and they are likely to be stunted. But if the same land is used for growing plants for their stems, leaves, rhizomes, tubers, or roots, such as the sugar-cane, tobacco, ginger, yams, or cassava, the yield will be small. Leguminous (or pod-bearing) plants enrich in nitrogen the land on which they grow, because they have on their roots small tubercles containing minute organisms (bacteria) which can render the

nitrogen of the air available for use. Other sources of nitrogen are artificial manures which may be purchased, such as nitrate of soda, sulphate of ammonia, and guano.

Phosphates and potash are present to some extent in farmyard manure and compost, but it is often convenient to obtain them commercially. Phosphates are sold as guano, superphosphate, and basic slag, which last is less soluble than the others; potash is supplied as kainit and sulphate of potash. A useful substitute for these is wood ashes, as they contain potash and some phosphoric acid, but no nitrogen.

The kind of manure required by a given soil is best decided upon from a knowledge as to what plants previously grew upon it and from indications given by the crops which it is producing; these indications, however, are useless in times of drought, as the first and most easily observable want is that of water. Lack of nitrogen is shown by paleness of the leaves, or by stunted growth; lack of phosphates causes the seeds to be small in number and size, while the plant may be normally developed; and that of potash results in poor crops of inferior fruit, while the ordinary growth is satisfactory.

The most useful and easily obtainable manures for school gardens are well-rotted stable manure, compost, and wood ashes which have been kept dry. Leguminous crops, such as peas, beans, and alfalfa, are a cheap source of nitrogen and may be advantageously grown in turn with other crops. Care must be taken that a plot is not allowed con-

stantly to produce one kind of crop, as this will result in the continuous removal of the same kinds of plant food. If it is desirable for any reason to employ artificial manures instead of those mentioned, they may be used in the proportions given below which are those for a plot measuring 20 feet by 5 feet :—

$1\frac{1}{3}$ lb. sulphate of ammonia, which gives about 40 lb. nitrogen to the acre.

$1\frac{3}{4}$ lb. nitrate of soda, which gives 40 lb. nitrogen to the acre.

$1\frac{3}{4}$ lb. basic phosphate, which gives about 40 lb. phosphoric acid to the acre.

$1\frac{1}{2}$ lb. superphosphate, which gives about 40 lb. phosphoric acid to the acre.

$\frac{1}{2}$ lb. sulphate of potash, which gives about 40 lb. potassium oxide to the acre.

If basic phosphate and sulphate of ammonia are to be applied to the same plot, the phosphate should be put on and worked in some days before the ammonium compound is added, as it is alkaline and will therefore cause the latter to give off ammonia if mixed with it, with the result that nitrogen is lost.

[A full account of a series of manurial experiments is given in *Nature Teaching*, pp. 180-5.]

PRELIMINARY LESSONS.

The following course of lessons is drawn up for the purpose of giving a methodical scheme for the *commencement* of plot-work in the garden. The lessons are in no way limited as to the duration of each by considerations of time, that is, any one of them may, and in most cases undoubtedly will, extend over several meetings of the class. Two objects have been kept in view in preparing it: firstly, that as little time as possible may be spent in waiting for plants that must be transplanted from boxes to come to the required stage for that purpose, and secondly, that every pupil may acquire at the outset a general knowledge of the different methods of planting. In the first connexion, it is easily seen that the time spent over Lesson II allows the ground as prepared in Lesson I to become ready for its treatment in Lesson III, and that a chance is given for the seeds planted in boxes in Lesson V to be ready for transplantation in Lessons VII and VIII. In the second case, at the meetings of the class for Lessons VII and VIII (after a short time has been spent in weeding and watering the plots started in Lesson VI), *the whole class* will be able to devote its attention, at the proper time, to those lessons. After this, the plots will be divided up among the pupils, the younger ones taking those started in Lesson VI, the older ones those in Lesson VII, and the oldest those in Lesson VIII, so that the teaching will now proceed in each case on the lines set down in the Special Instructions.

The stocks planted in one of the border beds for ubsequent budding and grafting will naturally not be required until the course is well advanced. In every case, they will be carefully removed after the buds and grafts have taken, leaving room for a new set.

As yams, ginger, cotton, cacao, etc., take a comparatively long time to come to maturity, it is most expedient to reserve special beds for them, which will be tended from time to time, as required.

A space should be reserved in one corner of the garden for the compost heap; its position will depend upon various circumstances, the chief one being the shape of the garden. It should be screened by hedges, and a few trees, to provide shade, may be advantageously planted near it.

A useful means of carrying manures, stones, etc., is supplied by nailing two long rods (about $1\frac{1}{2}$ inches by 1 inch in thickness) along the top of the long sides of a fairly deep box.

Pieces of wood, measuring about 12 × 2 inches × $\frac{3}{4}$ inch, should be nailed near each corner of the seed-boxes, about 9 inches being left free in each case to act as a leg. If small seeds such as those of the onion or lettuce have been planted in the box, the legs should stand in tins containing water covered with a little kerosene.

A plan of a schoolgarden is appended. This will of course have to be considerably modified in some cases to suit conditions. The plots marked A are intended for plants grown according to the Special Instructions I-VIII; plots marked B for

those mentioned in IX-XII, XXI and XXII, and those marked C for those mentioned in XIII-XX and XXIII. Those marked M may be reserved for manurial experiments.

At several points along the lowest border of the garden, drains, from 1½ feet to 2 feet wide, should be dug, sloping from the lowest path. The hedge may be trained across these.

LESSON I. PREPARING THE GROUND.

1. Provide the bigger boys with forks, and see that they turn up the soil to a depth of at least a foot.

2. This gang should be followed by one with hoes, with which the lumps of soil left by the first should be broken up.

3. A third gang is employed to pick out all devil's grass, nut grass, French weed, and purslane by hand. These are to be removed and placed in a convenient part of the garden to form the beginnings of the compost heap.

4. Go over the ground again as in 1 and 2, making rough trenches with the fork, in which the remaining weeds are placed; drag soil over them with the hoe.

5. Leave the ground untouched during the time taken up by Lesson II. Avoid walking upon it, as far as possible.

Chief Points for Explanation.—(*a*) The soil should be well broken up to a good depth to enable the roots to penetrate it easily in their search for plant food, and to ensure the necessary supply of air

for them. (*b*) Devil's grass, French weed, and purslane readily produce roots from the nodes of the running stem, and nut grass possesses tubers which are capable of giving rise to new plants, so that they will easily grow again if they are buried in the ground with the other weeds, whereas in the compost heap they will rot and form humus. Hence the greatest care should be employed in removing them. (*c*) If the other weeds are left in the ground, they will have partially rotted before the time comes for making the plot.

LESSON II. PLANTING HEDGES.

1. Place stakes at each corner of the unprotected sides of the ground intended to form the garden.

2. Using these as a guide, place shorter stakes between them in a straight line, at about 3 feet apart. This is best done by sighting along the end stakes (at the corners) and moving the shorter ones until they are in the same straight line and then driving them into the ground for a short distance.

3. Fork out trenches, about a foot deep and a foot wide, along the lines formed by the stakes.

4. Thoroughly break up the soil which is thrown out of the trenches, using the hoe, and drag it back into them. If manure is procurable, mix it well with the soil before putting it back into the trenches.

5. Procure cuttings (these should be readily found in the neighbourhood) of 'bread-and-cheese' (*Pithecolobium Unguis-cati*), privet or wild coffee (*Clerodendron aculeatum*), logwood, or other suitable hedge-plant. Prepare them, and plant them in the

loose soil in the trenches in the way described under General Instructions VI, paragraphs 2, 3, and 4.

LESSON III. PREPARING THE PLOTS.

1. Along the sides, in the direction of the slope of the ground, and along the one at the top of the slope, place rows of stakes at a distance of 3 feet from the boundary. It is best to use as few stakes as possible and to stretch lines of cord or twine tightly between them.

2. Fork out the soil to a distance of 2 feet on the inner side of the lines and to a depth of about 6 inches, throwing it up to form border beds 3 feet wide between the boundaries and the lines. Make the bottom of the trench flat so as to leave a path 2 feet wide.

3. If these instructions are followed, there will be three border beds (and paths), one running along the top of the slope and two running down it. From the inner edge of the path belonging to one of the latter measure distances of 5 feet and mark them with stakes.

4. Still proceeding inward from the line of stakes so formed, make a trench 2 feet wide and 6 inches deep, as in 2, and throw up the soil to make a plot 5 feet wide between the path and the stakes.

5. Continuing in the same way, remove the line of stakes 5 feet further on and make a path and plot as before, and repeat the process until the ground is divided up into plots 5 feet wide, run-

ning in the direction of the slope, with paths 2 feet wide between them.

6. With the hoe, open up a trench down the middle of each plot, place in it fairly well-rotted stable or pen manure, and draw the soil back over it.

LESSON IV. THE BORDER BEDS.

1. Divide one of these beds into three equal parts (*a*), (*b*), and (*c*).

2. In (*a*) plant hardy cuttings of rose (see General Instructions VI, 2-5); in (*b*) cuttings or young plants of sour orange; and in (*c*) sow seeds of a common, hardy variety of mango. The plants in each case should be 2 feet apart, and will, later on, be used as stocks for exercises in budding and grafting.

3. Along the edge of each of the other border beds plant cuttings of *Alternanthera* and keep them neatly pruned. Procure such flower seeds as can be obtained and sow them *with regularity* according to some prearranged design. If they are sown in rows, those which make the highest plants should be farthest from the edge, if in patches, they should be in the middle.

4. Water when necessary, and keep free from weeds.

LESSON V. RAISING SEEDLINGS FOR LESSONS VII AND VIII.

1. Prepare seed-boxes in the way described in General Instructions I.

2. In these sow seeds of such of the plants as are obtainable among those mentioned in Special Instructions IX-XX, and tend them in the manner there indicated.

LESSON VI. PRELIMINARY WORK IN EASY CULTIVATION.

1. Reserving plots for manurial experiments, the demonstration of the methods of cultivation of the yam and ginger and for other specialized work, carefully fork one-third of the remainder. It is found most convenient to choose neighbouring plots for this (*a*), but if every third plot is selected (*b*) it tends to a better appearance.

2. In these sow such of the plants as are obtainable among those mentioned in the Special Instructions, Nos. I-VIII.

3. Tend each kind of plant in the way described for it in the Special Instructions.

LESSON VII. PRELIMINARY WORK IN LESS EASY CULTIVATION.

1. As is indicated in Lesson VI, the plots for this lesson may be chosen in two ways, depending on the mode of selection for that lesson, i.e., if method (*a*) is followed, one-half of the remaining plots, or if method (*b*), one plot between each pair already occupied, will be used. In any case, carefully fork and prepare the plots selected.

2. Into these, if they are ready, transplant such of the seedlings sown in boxes in Lesson V as are

mentioned in Special Instructions, Nos. IX-XII, observing in each case the precautions there given. Onion sets, also, (XXI) may be sown in any of these plots.

LESSON VIII. PRELIMINARY WORK IN MORE DIFFICULT CULTIVATION.

1. Carefully fork and prepare the remaining beds. (See Lessons VI, and VII.)

2. Into these, when they are ready, transplant such of the seedlings sown in boxes in Lesson V, as are mentioned in Special Instructions, Nos. XIII-XX, and, if desired, plant the cuttings of XXIII.

SPECIAL INSTRUCTIONS.

I. TURNIPS.

1. Draw lines across the bed 6 inches apart, using a trowel and a straight wooden rod.

2. With the trowel make drills ½ inch deep along these marks.

3. Sow the seeds thinly and evenly in the drills.

4. Carefully fill in the drills with a rake and press down the soil with a spade or with the rod.

5. Water well, using a fine rose.

6. Weed carefully, and thin out the plants to 4 inches apart, when they are 4 to 6 inches high.

7. Weed, when necessary, keeping the soil loose with the hoe.

Time.—The turnips should be ready in from sixty to seventy days. If they are left in the ground too long, they turn yellow and become sour.

Soil.—A light, fairly moist loam.

II. RADISHES.

1. Mark out the beds and sow the seeds in the way described for turnips, making the drills somewhat deeper.

2. Rake the soil into the drills and press it down with a spade or rod.

3. Water, using a fine rose.

4. Weed, when required, keeping the soil loose with a scuffle-hoe.

5. Thin out by pulling up those ready for use, that is, those which are about as thick as the thumb.

Time.—About six weeks.

Soil.—A light, well-tilled soil.

III. CARROTS.

1. Mark out the beds and sow the seeds in drills made in the way given for turnips.

2. Having raked the soil into the drills and pressed it down, water with a fine rose.

3. Thin out to 2 inches apart when from 3 to 4 inches high.

4. Weed and keep the soil loose with the scuffle-hoe.

5. Take out the more advanced plants as they are ready for use, leaving room for the others to develop.

Time.—Three to three and a half months.

Soil.—Deep, well-drained, and light.

IV. BEETROOT.

1. Mark out the plots and sow the seed in drills, following the instructions given in the case of turnips.

2. Fill in the drills, press down the soil, and water, using a fine rose.

3. Keep free from weeds and thin out to 3 inches apart when the plants are from 3 to 4 inches high.

4. Weed, and keep the soil loose with a scuffle-hoe.

Time.—The beetroot is ready for use in about two months after sowing. It does not spoil if it is left in the ground a week or two after it has come to maturity.

Soil.—Beet grows best in a somewhat sandy soil.

V. PEAS.

1. Place two stakes at each end of the plot 2 feet apart and at equal distances from the nearest edge of it.

2. Stretch two lines, running along the length of the plot, between them, and carefully make trenches about 3 inches deep alone the lines.

3. Sow the seeds fairly thickly in the trenches, fill in, press down the soil, and water.

4. Thin out to 4 or 6 inches apart when the plants are about 3 inches high, keeping the plot free from weeds.

5. Weed when necessary, keeping the soil loose, and, one month after sowing, hill up the plants by drawing up the soil round them with a hoe so as to form banks.

6. At the time of hilling up place pea-sticks, or others suitable for the purpose, upright in the plot close to the peas on each side of the rows. The branches should have long twigs on them and should be placed near enough for the latter to touch, in order that the peas might run on them.

Time.—The peas, under favourable conditions are ready for use six or seven weeks after the seeds are sown.

Soil.—A sandy loam is the most suitable.

VI. BUSH BEANS.

1. Stake and line out the plot in the way recommended for peas.

2. Make holes about 3 inches deep, following the lines, with a short, straight rod (or dibber), 1 foot apart.

3. Sow two seeds in each hole, fill in the soil pressing it down with the foot, rake lightly, and finally water the bed.

4. Weed, and thin out the plants when they are about 4 inches high, leaving one in each hole.

5. Keep the plot weeded, and one month after sowing, hill up the plants by drawing the soil up around them to a height of from 4 to 6 inches.

Time.—Two to two and a half months.

VII. INDIAN CORN.

1. Stake and line out the plot in the way which was described for peas. The lines, however, should be 2½ feet apart.

2. Using the lines as a guide, make holes about 2 inches deep, and put two seeds in each hole. The holes should be 2 feet apart. Fill in as described above.

3. Weed, and hill the plants up when they are about 1 foot high.

4. Constantly remove and kill all caterpillars and put a little dry soil into the heart of the plant.

5. When the cob begins to be formed, bend back the top of the plant in order that as much of the plant food as possible may be used in its formation.

6. In wet weather, bend over the nearly ripened cob to prevent the corn from being spoiled by the rain.

7. When the cobs are ripe, pull them off and remove the husks.

8. Spread out the cobs to dry for a few days, before shelling.

Time.—The crop is ready to be gathered in from two to three months, when the grains will be hard and the sheaths around them white.

Soil.—The soil required for a good yield is a sandy, well-drained loam.

VIII. OCHROS.

1. Set out two lines 2½ feet apart in the way described for peas.

2. Make holes 2 feet apart, and about 1 inch deep along the lines, and put three seeds in each hole.

3. Fill in the holes, press the soil down with the foot, rake lightly, and water.

4. Weed carefully, and hill up the plants when they are 1 foot high.

5. Pick the fruits when they are from 2 to 3 inches long, allowing a few, however, to mature for the purpose of getting seed.

IX. LETTUCE.

1. Sow the seeds evenly over the surface of the soil in shaded boxes, and cover with a thin layer of sifted soil, taking precautions against ants.

2. Place the boxes in the sunshine after a week in order to harden off the seedlings.

3. Mark out the plots as for turnips, and make holes along the marks 4 inches apart, and 2 inches deep.

4. When the leaves of the seedlings are 1 inch or 2 inches long, water them, and plant them out in the holes, and press the soil carefully around them with a stick.

5. Water well, and shade from the sun for a week. Guava bush makes a good shade.

6. Weed when necessary and keep the soil loose.

7. The places of the plants that die out after being transplanted should be supplied from those left in the box.

Time.—The lettuce is ready in about eight weeks and remains good for some time longer.

Soil.—A soil treated with well-rotted manure is the most suitable for lettuce.

X. CABBAGE.

1. Sow the seeds thinly in boxes and cover with

¼ inch of fine soil, taking care that the seeds are not carried away by ants.

2. Stake out lines 2 feet apart along the plots, and, guided by the lines, make holes 2 inches deep and 1 foot apart.

3. When the seedlings have reached a height of about 4 inches, water them well, and plant them out in the holes, pressing the soil well around them, and water them again.

4. Keep the plots weeded, and shade the plants for a week.

5. Hill up the plants when they are sufficiently high.

6. Rid them of caterpillars which give much trouble, and reap when the heads are hard and compact.

Time.—The cabbages should be ready in about three and a half months.

Soil.—A deep, well-drained soil, the particles of which stick together, is most suitable for cabbage.

XI. ONIONS.

1. Sow the seeds in boxes, and carefully cover with a thin layer of soil, pressing it down firmly. Ants should be carefully guarded against.

2. Plant out the seedlings when they have three or four leaves, in holes 4 inches apart, made in rows 1 foot apart, the plot being marked out as for turnips.

3. Press the soil round the seedlings and afterwards water the bed.

4. Keep weeded, and loosen the soil with the scuffle-hoe.

5. Supply dead holes from the seedlings left in the box.

Onions may be sown in beds directly, and thinned out in exactly the same way as was described in the case of turnips, but there is the danger of the seeds being carried off by ants in this case.

Time.—About six months.

Soil.—A fairly light loam, well manured with natural nitrogenous manures, such as those from poultry houses, stables, and cattle pens.

XII. LEEK.

1. Sow the seeds in boxes as for lettuce, placing a layer of manure in the bottom of the box.

2. Mark out the plot in the way described for turnips, making the marks 9 inches apart.

3. Make trenches 3 inches deep along the marks, leaving the soil from the trenches between them.

4. In the trenches make holes about 3 inches deep, and 4 to 6 inches apart, with a straight, pointed stick or dibber.

5. Plant the seedlings out in the holes and water them.

6. Weed, keeping the soil stirred up, when required, and, when the plants are well established, fill in the trenches with the soil taken from them. (See Instruction 3 above.)

Leeks, like onions, do not require shade.

Time.—About six months.

Soil.—Light and well-manured.

XIII, XIV, XV, AND XVI, MELON, SQUASH, PUMPKIN, AND VEGETABLE MARROW.

1. Sow the seeds in boxes in holes 1 inch deep made with the finger, putting two seeds in each hole.

2. Make marks across the plot 4 feet apart, and spread stable manure or compost along the marks.

3. Draw up the soil from between the marks so as to make banks over the manure.

4. Plant out the seedlings when they are 4 inches high, in holes 2 inches deep, and 2 feet apart, on the top of the banks. Water well.

5. Weed when required, keeping the soil loose. Great care should be taken to avoid injury to the roots of the seedlings when transplanting them. If slugs threaten the young plants surround the latter with white lime. Thin out the fruits when young; this will result in larger fruits which ripen more quickly.

Time.—Two and a half to three months for all. Two rows of cuttings may be planted on each bank except the squash.

Soil.—Light, treated with well-rotted manure.

XVII. CUCUMBER.

1. Sow the seeds in boxes in holes 1 inch deep made with the finger.

2. Place stakes down the centre of the plot 4 feet apart, beginning at 2 feet from one end. (In the case of a plot 20 feet long this will give a row of five stakes with a clearance of 2 feet at each end.)

3. Around each stake open a hole 3 feet square and 1 foot deep.

4. Mix the soil from the holes with an equal quantity of well-rotted farmyard manure and put it back so that a hillock is formed in the position of each of the stakes.

5. Add soil, taken from around the hillocks and mixed with manure, until they are 1½ feet high.

6. Make a hole with the trowel, about 4 inches deep in the top of each hillock, and, when the seedlings are about 5 inches high, plant two in each hole to a depth equal to about three-quarters of the length of their stems.

7. Water the seedlings and shade with guava bush.

8. Thin the plants out to one in each hole, keep weeded, and nip off all flowers formed within a month after planting.

Sweet calabash may be raised in the same way as cucumber, but the hillocks should be somewhat larger.

Time.—About two and a half months.

Soil.—Sandy, and thoroughly well-manured.

XVIII. TOMATO.

1. Sow the seeds in boxes thinly and evenly and cover them with a thin layer of sifted soil.

2. In three weeks, transplant the seedlings into other boxes containing soil mixed with fine compost, putting the plants 4 inches apart.

3. Along the plot place two rows of stakes each 1 foot from its centre, the stakes being 2¼ feet apart in the rows, beginning 1 foot from the end of the plot. (This, in the case of a 20-foot plot, gives nine stakes in each row with 1 foot clearance at the ends.)

4. Open holes 9 inches to 1 foot deep and 1 foot square round each of the stakes.

5. Mix the soil from the holes with about an equal amount of farmyard manure, or compost, and put it back into them.

6. Water the boxes, and when the seedlings are 6 inches high plant them, after hardening off, in the positions of the stakes, in holes made about 6 inches deep with a trowel.

7. Water the seedlings well. Shade them at first with guava or other suitable bush, and keep the plot weeded.

8. When the plants are high enough, drive stakes, each about 4 feet high, into the ground near them, and tie the plants to them with plantain trash or any other suitable soft material.

9. Allow each plant to develop only two or three branches by carefully pinching or rubbing off the buds which are not required. This causes better fruits to form on the branches that are left.

10. When flowering has begun, top the plants

by cutting them off a short distance above the highest bunch of flowers.

Time.—About two and a half months.

Soil.—A sandy, heavily manured soil, mulched, and watered well until the plants begin to mature.

XIX. EGG PLANT.

1. Sow the seeds in boxes and transplant into others in four weeks, in the way given for tomatos.

2. During the last week harden off the seedlings in the sun; then, when they are 6 inches high, plant them in holes made exactly like those for tomatos.

3. Water the seedlings, and weed when required.

4. When the plants are high enough, loosen the soil with a hoe, and draw it up around them, in order that they may become securely fixed in the ground by the development of new roots.

5. Disbud, as in the case of tomatos. When the fruits begin to ripen, pinch off the ends of the branches.

Time.—About five months.

Soil.—As for tomatos.

XX. PEPPERS (Capsicums).

1. The seedlings are raised in boxes in exactly the same way as those of the tomato and egg plant.

2. Plant out when 4 inches high in holes 2 feet apart, made in exactly the same way as for tomatos.

3. Water and weed, supplying dead holes from

the plants left in the box, as usual. Shade should be supplied at first.

Time.—The first peppers should be obtained in about sixteen weeks.

XXI. ONIONS (Sets).

1. Make straight marks across the plots, in the way recommended for turnips, 1 foot apart.

2. Plant the sets 6 inches apart along the marks, by holding them between the thumb and first finger with the shoot end upwards, and pushing them into the soil to a depth of about 2 inches. This method causes the soil to be pressed firmly round them, so that they do not rise out of the ground later on. Water them if the weather is dry.

3. Weed very carefully, as the plants when young resemble nut grass, with which they may be confused.

4. Keep the soil stirred with a scuffle hoe.

5. Pull the onions when their oldest leaves begin to turn yellow and they feel loose in the ground.

6. To dry them, expose them to the sun for a day, and then spread them out thinly under cover.

7. When they are quite dry, the tops may be twisted off and the roots cut away.

(Time and soil ; see XI.)

XXII. ENGLISH POTATOS.

1. Place two stakes at each end of the plot 1 foot from the centre, and stretch lines along the plot between them.

2. Using the lines as a guide, take out two shallow trenches about 6 inches deep with a hoe.

3. Cut the large potatos into pieces, each with buds on it, and rub wood ashes over the cut surfaces, or, better, dip them in Bordeaux mixture. Do not cut the small ones.

4. On the same day as the pieces are cut, place them in the trenches 1 foot apart, and fill in the latter.

5. Keep the plot weeded, and the soil between the plants loose.

6. When the leaves of the plants begin to wither, dig the potatos by driving the fork deep into the soil at a short distance from the plants and lifting them out.

7. Dry the potatos by spreading them out thinly under cover.

If imported sets are used, they should be spread out on a damp layer of soil to sprout. When the shoots are ¼ inch long, the sets are ready to be planted.

Soil.—A naturally dry, rich loam.

XXIII. SWEET POTATOS.

1. Place stakes down each long side of the plot 3 feet apart and opposite each other.

2. Make banks across the plot between the stakes.

3. Make cuttings from healthy potato vines by cutting off pieces 9 to 12 inches long just below a leaf.

4. With a dibber, make holes 12 inches apart on the banks, and, having removed the leaves from the three lowest nodes, push the cuttings into the holes until the leafless part is buried.

5. Press the soil round the cuttings and remove the leaves if the weather is dry.

6. The banks will only require weeding at first.

Time.—The time required for the potatos to come to maturity is from three to four months.

Soil.—A sandy, fairly dry soil is the most suitable one for sweet potatos.

XXIV. GINGER.

1. Beginning 1 foot from the end of the plot, place a row of stakes, 3 feet apart, down each of its long sides.

2. Spread compost or farmyard manure between opposite stakes.

3. Draw the soil over the manure between the stakes, forming banks 3 feet apart. Remove the stakes.

4. Cut the hands of ginger into pieces, each about 2 inches long, so that there are one or two buds on each piece.

5. Plant the pieces so obtained on the top of the banks, 1 foot apart and about 3 inches deep.

6. Water well, and weed when required.

7. When the plants are high enough, i.e., in about three months from the time of planting, break up the soil between the banks, mix it with compost, and draw it up around them on the banks.

8. When the leaves die down, lift out the hands with the fork.

Time.—Ginger is ready for reaping in about nine or ten months.

Soil.—It thrives best on a rich, light, well-drained soil.

To dry the ginger, first cut off the roots, wash away the adhering soil, plunge the 'hands' in boiling water for a few minutes, and finally spread them in the sun.

XXV. YAMS.

1. Give the plot a plentiful supply of manure, forking it well in.

2. At least one day before planting, cut the yams into small pieces, having one or two good buds on each of them, and rub wood ashes on the cut surfaces, or dip them in Bordeaux mixture. Small yams should not be cut.

3. Place two stakes at each end of the plot, 1 foot on either side of the centre, and stretch lines between each pair along the plot.

4. Beginning at 1 foot from one end of each line, push pronged stakes 5 or 6 feet long into the plot 3 feet apart along the line. (In the case of a 20-foot plot this gives seven pronged stakes in each line with a clearance of 1 foot at each end.)

5. Remove the lines, also the stakes at the end of the plot, and, near each of the remaining stakes, make a hole 6 inches deep with a trowel.

6. In each of the holes plant one of the cut pieces, cover them, and water if the weather is dry.

7. Keep the plot weeded, and, when the plants are high enough, tie them to the stakes.

8. Keep the soil loose with a scuffle-hoe.

Time.—Yams are generally ready for use in about nine months after planting. If they are not staked the tubers produced are likely to be small.

Soil.—The best yield is obtained in a rich, light, well-tilled soil of a good depth.

Budding, Grafting, and Pruning.

T or Shield Budding.

1. Prepare budding-tape in the way described in *Nature Teaching*, p. 58. If for any cause it is found difficult to make this, adhesive plaster, or the tape used for electrical fittings may be employed.

2. Provide actively growing branches of the plant to be grafted on to the stock. These should be of the same species as the stock, but of a superior kind, as the object of budding is the propagation of better varieties. A good rose, hibiscus, or orange forms suitable material.

3. The stocks should have been raised in nursery beds, and of a variety hardier than, and inferior to, the scion (see 2). They should be about as thick as the finger in the case of the orange, but thinner if the rose or the hibiscus is used.

4. Make a T-shaped cut in the bark of the budding-stock, about 4 inches above ground, with the cross cut about $\frac{3}{4}$ inch long, and the downward one about 1 inch long.

5. Remove a bud from one of the branches chosen (see 2, above) together with a thin slice of the wood about ¾ inch long and ¼ inch wide. The leaf, in whose axil the bud is, should be trimmed off fairly close so as to leave a small portion of the leaf-stalk.

6. Carefully loosen the bark at the angles of the T-shaped cut on the stock with the flat end of the handle of the budding-knife, and, taking hold of the piece of bark bearing the bud by means of the part of the leaf-stalk left on it, slip it down beneath the raised corners of the cut bark on the stock with the bud pointing upwards, until the top end of the piece of bark bearing the bud is just below the cross cut. (An ordinary sharp knife may be used instead of a budding-knife, the bark being raised by means of the blade.)

7. Tie a thin piece of soft string once round the stock over the downward cut to keep the bud in place.

8. Starting just below the cut, wrap budding-tape around the stock with the edges overlapping so as to cover the whole of the cut, but leaving the bud just exposed. Press the loose end of the tape on the wrapped part to fix it finally in position. Do not tie it.

9. In about two weeks remove the tape. Pinch off all ordinary buds which develop on the stock.

10. Remove the part of the stock above the bud by first cutting it partly off, about 2 inches from the point of insertion of the bud and bending it over; then, when a good branch has been formed, complete the operation by cutting the stump completely through, just above the new branch arising from the bud. Smear grafting wax or tar over the cut part of the stump.

Patch Budding of Mangos.

1. For stocks, select stems at least an inch thick. These will be obtained from seedlings of from two to three years old.

2. Remove a rectangular piece of bark about ¾ inch square from the stock.

3. Choose the bud-wood from the parts (of trees of good varieties) which have lost their leaves. Each bud should have a piece of wood attached to it of the same shape as, and slightly larger than, the piece of bark taken from the stock.

4. Fit the piece of bark with the bud on it neatly and carefully into the place prepared for it on the stock, and smear grafting wax where the edges of the bark of the stock, and those of the bark attached to the bud come together. This prevents the drying up which, in the case of mangos, causes T budding to be so unsuccessful.

5. Bind moderately tightly with twine, and wrap with tape in the usual way.

6. If the part is exposed to the sun, shade it with leaves or strips of paper tied on to the stock.

7. After two or three weeks, remove the tape and loosen the twine.

8. Gradually remove the part of the stock above the bud in the way described under T budding.

Chief Points for Explanation.—(*a*) Budding is practised for the purpose of propagating good or desirable varieties of plants, because it is never certain that those raised from seed will show in the same degree those qualities for which the parent,

was especially valued, whereas buds always 'come true,' as it is termed. (*b*) The time during which the operation is performed is chosen during a period of active growth in order that there may be a plentiful supply of food to the inserted bud. (*c*) The result aimed at during the whole process is to get the cambium (which is the region of growth) of the stock and of the portion removed with the bud to unite. Point out that monocotyledons cannot be budded as they have no cambium. (See *Nature Teaching*, pp. 46-8). (*d*) The gradual removal of the portion of the stock above the bud causes the current of sap to stop near it, thus providing it with a good supply of food. (*e*) If other buds are allowed to form branches the supply of food available for the one which is intended to develop is lessened. (*f*) The budding-tape prevents loss of moisture from the cut parts.

Grafting.

1. Make a supply of grafting-wax, following the instructions given in *Nature Teaching*, pp. 57 and 58.

2. *a. Tongue Grafting.* (Also called splice grafting and whip grafting.) Cut the stock back until it is about the same size as the scion ('heading down'), pare it down for about 1½ inches on one side in a sloping direction, and cut a wedge-shaped piece out of the top. Shape the scion in exactly the same way at the bottom, and on a level with a bud, and force it securely into the top of the stock so that the cambium layers are accurately in contact

on one side and the cut surfaces fit together perfectly. Bind the parts firmly together with twine and cover with overlapping turns of budding-tape, or with grafting-wax.

b. Wedge Grafting. Cut a wedge-shaped piece out of the stock, taking the cut well up to the edges. Trim off the scion to a wedge-shape at the lower end just below a bud so that it will just fit into the cut in the stock, and force it into the latter so that the cambium layers touch on one side at least. Bind as in *a.*

c. Saddle Grafting. Cut the stock and scion as in *b*, but make the wedge at the upper end of the *stock.* In this, as in *b*, make the cuts so that the cambium layers will come into contact as nearly as possible when the parts are fitted together. Push the scion on to the stock and bind them together in the way described for tongue grafting.

d. Crown Grafting is the method used when the stock is much thicker than the scion, and is very useful when sweet oranges are to be grown on sour orange stocks. In this, a thin wedge is made at the lower end of the scion, and this is thrust into the stock between the bark and the wood. Or, a V-shaped piece of bark, with a little of the wood, is taken out of the side of the stock at the top, and the lower end of the scion trimmed so that it can be fitted into the cut in the stock with a piece of its bark left on the outside. In both cases, after fitting, the top of the stock is bound up with twine or budding tape, and grafting-wax pressed firmly over the cut parts. By these methods several scions may be inserted on one stock.

e. Grafting by Approach (inarching). In this case both stock and scion must be capable of being brought close together while actively growing with their roots in soil, so that the scion is either grown close to the stock or in a pot; the simplest way is to grow them both in pots. Cut a shaving about 2 inches long from each, removing the bark and part of the wood. Bind the cut parts together with twine so that the cambium layers are as much as possible in contact, and cover with grafting-wax. When the parts are completely united, cut the graft partly through, deepening the cut from day to day until it is fully severed. This method is usually employed in the case of mangos. Budding-tape may be used as a covering instead of grafting-wax.

3. Crotons, sweet orange scions and bitter orange stocks, roses, mangos, and the egg plant form good material for grafting. In the last case, the cultivated variety, or even the tomato, grafts readily on to the wild egg plant, so much so that they should be always used in the simple exercises preparatory to the practice of the more difficult kinds of grafting.

4. Keep grafted plants shaded at first, and water them well.

5. Rub off all shoots from the stock and, later on, when the graft has branches and leaves of its own, prune off all, or nearly all, the branches left on the stock.

Chief Points for Explanation.—(*a*) The use of grafting-wax is to hold the parts securely together in crown grafting and to prevent the escape of moisture from the cut surfaces. (*b*) As in budding, the

chief object is to get the actively growing regions (the cambium) into intimate contact so that the attempt to heal the wounds may result in the joining of the parts together; grafting cannot be employed in the case of monocotyledons, which have no cambium. (*c*) In grafting by approach the scion is severed gradually in order that sudden stoppage of the supply of food may be avoided. (*d*) If branches are allowed to grow on the stock after the scion has been well established the latter is naturally robbed of nutriment. (See *Nature Teaching*, pp. 49-54 and 57-66, and Nicholls' *Tropical Agriculture*, pp. 82-5.)

Pruning.

In some cases, in order that the plant may develop to the best advantage, the removal of some of its parts is necessary. This removal, called pruning, should be effected with care and thought, and special regard should be taken as to the avoidance of injury to the plant and the result which is desired to be attained. Simple examples of pruning occur in the ordinary care of plants; these are described in their proper places and serve admirably as a means of giving correct ideas as to the necessity of constant careful treatment. A summary of these is given below:—

(1) *Pinching.*—The removal of terminal buds by means of the finger and thumb. This is used in the case of the tomato, and in those in which it is desired to promote branching low down on the stem.

(2) The removal of shoots near the base of the

stem (Indian corn), in the axils of the leaves (tomato, egg plant, tobacco), or suckers (agave, banana), in order to prevent the withdrawal of food from the parent plant.

(3) *Disbudding.*—The removal of buds, as in grafted stocks, to prevent branching.

(4) *Topping.*—In this, the flower-stalk is cut away in order that the food which would otherwise be used in the production of seed may go to form other parts of the plant. It is employed in the case of those which are grown for their leaves, such as tobacco.

(5) The removal of some of the immature fruits from a plant so as to enable the remaining ones to become larger. This is employed in the case of the tomato and egg plant.

(6) The removal of flower-buds from a plant when strong vegetative growth is required, or, in the case of the tomato, melon, cucumber, etc., when young, to prevent exhaustion by too early fruit-bearing.

Special Exercises in Pruning.

1. Choose two lots of plants (*a* and *b*) of physic nut, hibiscus, rose, or Acalypha Prune (*a*) regularly, making the cuts just above the inside buds, i.e., those towards the main stem. Treat (*b*) in a similar manner, but make the cuts just above the outside buds. All branches arising subsequently should be treated in a similar manner when they themselves begin to form buds, and it will be found

that (*a*) will assume a somewhat dense upright form, while that of (*b*) will be spreading.

2. Taking other plants of the same kind, pinch off the uppermost terminal buds, during the period of active growth in the case of lot (*a*), and constantly cut back the lower branches of lot (*b*). The plants (*a*) will grow *stocky*, that is, they will have a low, dense head, while (*b*) will eventually be *slender*.

3. To provide shade :—Persistently pinch off the end buds of the branches so that they may be caused to form others further back on themselves, instead of growing long and slender. This process may be employed with advantage in the case of shade trees for nursery beds.

4. To admit light and air :—This is especially applicable to the orange and other trees which are grown for their fruits or seeds. Prune away the smaller branches at a distance from the trunk, as the cutting of the main branches may result in serious injury to the tree. The free admission of light and air to the inner branches and leaves results in increased carbon assimilation and more rapid ripening of fruit. (See *Nature Teaching*, pp. 78-83.)

5. To promote growth :—Well-established plants which have been transplanted should have a part of the branches removed so as to reduce the number of growing points and leaves. This should also be done in the case of fruit trees which have become exhausted through bearing a large crop.

6. To protect the plant:—Dead or dying branches, especially those which are infected by scale insects or

fungi (blights) should be removed as soon as found, as if they are allowed to remain, they may cause decay of the main stem. In addition, healthy ones which are likely to interfere with those already formed should be pinched or cut off. The removal of large branches should be performed in the following manner: (*a*) Make a mark round the branch to show the position of the cut. This should be such that the cut will be as near to the main trunk as possible and straight across the branch. (*b*) Using the mark as a guide, with a saw, cut the branch half way through beginning at the *under* side. (*c*) Complete the cut, commencing at the upper side. (*d*) Cover the cut surface with tar or paint. All such cuts should be clean; there should be no hacking.

General Remarks.—The prevention of the growth of a plant in one way causes it to develop in another, thus the removal of the lower buds of a dicotyledon causes branching higher up, so that a good head is formed on the top of a naked trunk (2 *b*), while pinching the terminal buds gives rise to a low, stocky growth owing to the development of buds low down on the stem and the check to increase in height. Again, vegetative growth is promoted by the removal of flower-buds, and increased branching by that of end buds; in fact, the process of pruning depends on the facility with which a plant responds to checked growth in one direction by increased growth in another.

In removing larger branches, the instructions (exercise 6) should be carefully followed for the following reasons: (*a*) If the branch is cut off at

some distance from the stem, the part left is likely to die back and cause decay in the main trunk. (*b*) A cut made straight across has a smaller area than an oblique one, and the activity of the cambium will cause it to callus over (i.e., heal) more quickly. (*c*) Making the cut from above causes the whole weight of the branch to be thrown on a small section of it, with the result that the trunk is likely to split down and a large wound is made, which may permit the entrance of disease before it has had time to heal, and which certainly causes disfigurement to the tree. (*d*) The application of a coat of tar or paint protects against the entry of disease until natural healing has taken place.

In transforming a large orange (or other) tree into a stock for budding purposes, cut it half-way through at first, and in six weeks cut it off altogether. This reduces the area to be healed at one time. Such stocks should be allowed to shoot again before they are used.

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